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EXAMINING CONSTRUCT VALIDITY AND MEASUREMENT INVARIANCE OF MOOD ACROSS GENDER AND GRADE

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ABSTRACT

The purpose of this study was to (a) test the construct validity of the visual analogue scale (VAS) for junior high school and (b) examine the measurement invariance of VAS across gender and grade. This survey study focused on construct validity and multi-group confirmatory factor analysis (MGCFA) across genders and grades using data from 1,463 students in Grade7, 8 and 9. Confirmatory factor analysis (CFA) was supported as model which consisted of both genders and include Grades 7 to 9. MGCFA, measurement invariance was non-invariance for both genders and all grades.

KEYWORDS: Construct Validity, Measurement Invariance, Mood

INTRODUCTION

Mood has a profound influence on information processing. It has been show that positive mood increases heuristic processing and negative mood increases systematic processing. Mood is seen as including: alertness (alertdrowsy, attentive-dreamy, lethargic-energetic, muzzy-clearheaded, coordinated-clumsy, mentally slow-quick witted, strong-feeble, interested-bored, incompetent-proficient), calmness (calm-excited, tense-relaxed), and contentedness (contented-discontented, troubledtranquil, happy-sad, antagonistic-friendly, withdrawn-sociable). (Srikoon, S., Bunterm, T., Nethanomsak, T., and Keow, N., T., 2017). Therefore both positive and negative moods influence information processing in learning (Armitage, Conner, & Norman, 1999).

For over 90 years the visual analogue scale (VAS) has been used for the assessment of subjective phenomena (Freyd, 1923; Hayes & Patterson, 1921). Moreover, VAS provides a simple technique for measuring subjective experience across a range of clinical and research situations (McCormack, de L. Horne, & Sheather, 1988). Nowadays, VAS can be used to detect changes in mood (Ahearn, 1997; Monk, 1989).

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The problems of measuring mood are highly complex and it is questionable whether measurements from VAS whether the VAS was consistent with theory in education context. The effect of mood on the learning process is taken into consideration because mood can enhance learners' information processing (Hardiman, 2012). Certainly, if VAS does properly fit and measure mood in students then teachers can use it for classroom management.

The main variables for managing learning in classrooms are gender and grade (Hagborg, 1992; Hishinuma & Tadaki, 1997). To date, gender and grade are considered conditions for learning in classroom. (For examples please refer to- Ellenbogen, Young, Dean, Palmour, and Benkelfat (1996); Cyders (2013); Beaver, French, Finch, and Ullrich-French (2014); Harrell-Williams, Sorto, Pierce, Lesser, and Murphy (2014); Siegling, Furnham, and Petrides (2015)). Therefore,The primary purpose of the current study was to test the construct validity of the VAS with its consistency when applied to each gender and grade.

Furthermore, the rapid growth of advanced analyzing methodology allows us to analyze the construct validity across groups using "multiple group invariance confirmatory factor analysis (MGCFA)". MGCFA is used to compare latent variable means, variances, and covariances across groups while holding measurement parameters invariant. (Asparouhov and Muthén, 2014; Marsh, 1994; Wang and Wang, 2012). In other words, MGCFA consists of two different kinds of invariance: measurement invariance and structural invariance. Measurement invariance is tested first and then structural invariance. There are four levels of measurement invariance consists of testing measurement configural invariance, weak measurement invariance, strong measurement invariance, and strict measurement invariance. The testing of structural invariance consists of three levels: invariance of factor variance, invariance of factor covariance, and factor mean invariance. Thus, testing MGCFA can give results for metric invariance, scalar invariance and invariance of structural parameters across groups (Wang and Wang, 2012; Dimitrov, 2010). Therefore, the underlying construct has the same theoretical structure and psychological meaning across the groups. These methodology may help to concern about information parameter in education (Byrne, 2008). Moreover VAS was origined in foreign land and was used much in educational research so that this research need to study the costruct of the VAS in Thailand students. Thus, a second purpose of the current study was to examine the VAS of MGCFA across gender and across grades.

CONCEPTUAL FRAMEWORK

This research have the conceptual framewore as below.

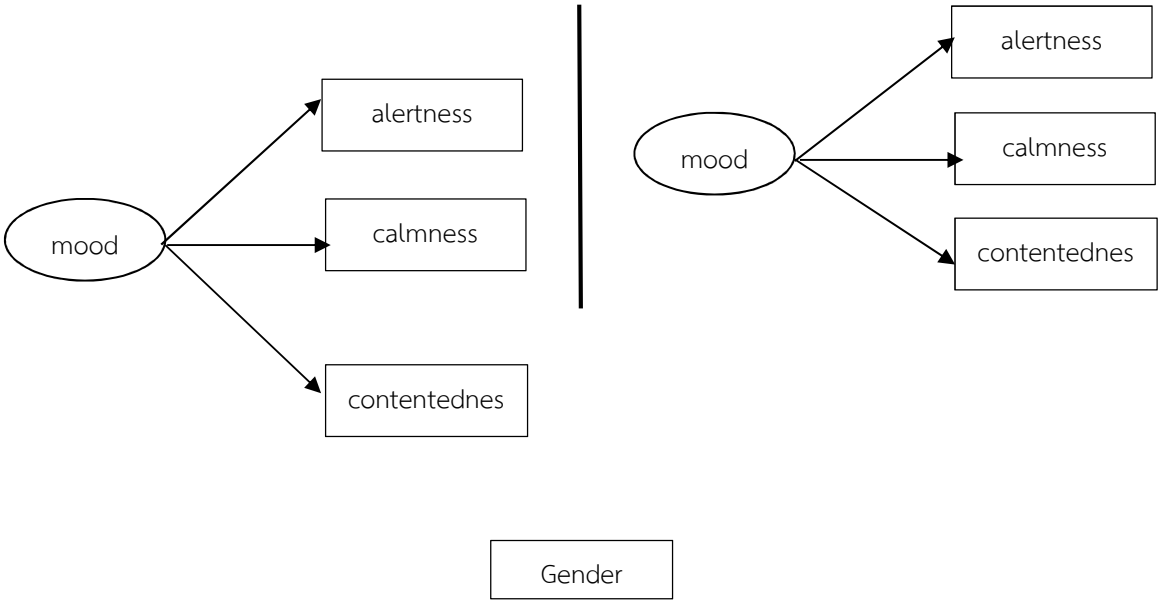

Figure 1 Conceptual Framework

RESEARCH OBJECTIVES

VAS should be precisely measured to examine the nature of construct and to make valid explanations for each individual's social activity. This study aimed to validate the VAS and further address measurement invariance across gender and grade. The specific purpose of this study are as follw:

1. To test the construct validity of the VAS with the consistency idea in each gender and grade.
2. To examine the measurement invariance of VAS across gender and grade.

RESEARCH METHODOLOGY

1. Population and Sample

This research was the survey research. The population of 31,876 students in 2016 academic year was draw by stratified random sampling from Grade 7- Grade 9 students in Secondary Educational Service Area Office 32, Thailand. The study sample (N= 1969) was draw from Grade 7 (N_1= 648), Grade 8 (N_2= 660) and Grade 9 (N_3= 661). The responses for one or more items were missing for two subjects in Grade 7, 260 in Grade 8 and 244 in Grade 9. These cases were excluded, resulting in a sample of 1463 students where there

was 646 Grade7 (44.156%) (415 male: 28.366%, and 231 female: 15.789%), 400 Grade 8 (27.341%) (136 male: 9.296%, and 264 female: 18.045%) and 417 Grade 9 samples (28.503%) (175 male: 11.962%, and 242 female: 16.541%).

2. Instrument and variables

Bond-Ladder visual analogue scales, using 16 horizontal 10 cm scale were used to assess mood to confirm three mood factors: "alertness" (alert-drowsy, attentive-dreamy, lethargic-energetic, muzzy-clearheaded, coordinated-clumsy, mentally slow-quick witted, strong-feeble, interested-bored, incompetent-proficient), "calmness" (calm-excited, tense-relaxed) and "contentedness" (contented-discontented, troubled-tranquil, happy-sad, antagonistic-friendly, withdrawn-sociable). Reliability is 0.898.

3. Data Collection

Sample in Grade7, 8 and 9 were filled with questionnaires in December, 1st-29th 2017.

4. Data Analysis

The mean value ($\bar{X}$), standard deviation (S.D.), skewness (sk) and kurtosis (ku) of the 35 items of the research skills are presented with descriptive statistics. Skewness values between 2 and -2 and kurtosis values between 7 and -7 were estimated as normal.

Confirmatory factor analyses (CFA) were analyzed using version 6 of the MPlus program (Muthen and Muthen, 2010). The CFA was used to test the hypothesized seven-factor model consisting of 35 items in all samples, for each gender and for each grade. Covariance structures were fitted with the maximum likelihood method. The model fit was evaluated by means of several fit indices. Universally, the model is considered acceptable when the probability the value (p-value)>0.05, the value of the ratio between the chi-square statistic and the degree of freedom (χ^2/df) is 2:1(Hair, 2006), the Comparative Fit Index (CFI)≥0.90 and good when≥0.95 (Bentler, 1992; Hu and Bentler, 1999) and the Tucker-Lewis coefficient (TLI) ≥0.95 indicates good fit(Sharma, Mukherjee, Kumar, and Dillon, 2005). Moreover, Standardized Root Means Square Residual (SRMR) should not exceed 0.08 for a good fit (Hu and Bentler, 1999). Furthermore, the Root Means Square Error of Approximation (RMSEA) value≤0.06 is considered indicative of a good fit, ≤0.08 a fair fit, between 0.08 and 0.01 a mediocre fit and > 0.01 a poor fit (Hu and Bentler, 1999; MacCallum, Browne, and Sugawara, 1996).

MGCFA is often used to test factorial invariance that consists of two different kinds of invariance (Dimitrov, 2010; Wang, J., and Wang, X., 2012). The following models were estimated with MPlus and compared sequentially by testing the decrease in model fit : (a) testing measurement configural invariance (b) testing weak measurement invariance (c) testing strong measurement invariance (d) testing strict measurement invariance(e) testing factor variance invariance (f) testing covariance invariance and (g) testing mean variance (Wang, J., and Wang, X., 2012).

The analysis of MGCFA was based on the Satorra-Bentler scaled chi-square statistics, and the Maximum Likelihood (MLX^2s) because it serves as a correction of chi-square when distributional assumptions are violated. When testing models we can evaluate the goodness-of-fit using multiple criteria including CFI, RMSEA, 90% confidence interval, and SRMR (Byrne, 2008). CFI values in the range of 0.92 to 0.94 are also considered reasonable indicators of good model fit (Marsh, Hau, and Wen, 2004). RMSEA values less than 0.05 indicate good fit, and values as high as 0.08 represent reasonable errors of approximation. (Browne, 1992). For completeness, Byrne's 2008 guide to reporting 90% confidence intervals provide for RMSEA (Steiger, 1990). The last index, SRMR has values ranging from zero to 1.00, with a value less than 0.08 being indicative of a well-fitting model (Hu and Bentler, 1999).

RESULTS

1. Descriptive statistics

The descriptive statistics including means, standard deviations, skewness, and kurtosis ware presented in Table 1. There are reported for each gender, each grade, and the total.

All items in VAS are distributed normally when compare with criteria: skewness values between 2 and -2 and kurtosis values between 7 and -7 are estimated as normal.

2. Construct validity in each gender, each grade, and total.

CFA was used to evaluate the goodness of fit. All CFA were conducted using M-Plus. Model fit was assessed using x^2 , x^2/df, CFI, TLI, RMSEA, and SRMR. Fit indices of all CFA models are presented in Table 2. All the measures indicated there was a goodness of fit between the empirical data and the hypothetical measurement model for all models. In other words, all the p-values in each CFA model were not significant (0.0641-0.1002), x^2/df values were less than 2:1 (1.227-1.254), and all CFI ≥0.95 indicating a good fit (0.991-0.998). Similarity, all TLI≥0.95 were a

good fit (0.987-0.996) and all RMSEA ≤0.06 were also considered indicative of a good fit (0.012-0.025). Finally, all SRMR ≤0.08 are acceptable values for a good fit (0.016-0.031), also.

Individual parameters estimated for all CFA models were also examined. Table 3 lists the standardized factor loadings for each latent variables for all CFA models. Another, Table 4 shows factor correlations between latent variables in each CFA model. As can be seen in the table, factor loading of items in each CFA models were all positive and statistically significant.

Table 1 Means, standard deviation, skewness, and kurtosis

items	gender								grade												Total (n=1463)			
	Male (n=542)				Female (n=921)				Grade7(n=646)				Grade 8(n=400)				Grade 9(n=417)							
	$\bar{x}$	S.D	sk	ku	$\bar{x}$	S.D.	sk	ku	$\bar{x}$	S.D.	sk	ku	$\bar{x}$	S.D.	sk	ku	$\bar{x}$	S.D.	sk	ku	$\bar{x}$	S.D.	sk	ku
Alarm																								
Item1	5.20	2.10	0.28	0.43	5.23	1.90	0.11	0.50	5.32	1.96	0.09	0.80	4.90	2.15	0.30	0.11	5.35	1.77	0.39	0.43	5.22	1.97	0.18	0.49
Item3	5.59	2.34	0.06	-0.39	5.39	2.02	0.17	0.02	5.53	2.08	0.09	0.14	5.30	2.27	0.20	-0.26	5.50	2.11	0.17	-0.37	5.46	2.14	0.14	-0.14
Item4	5.69	2.25	0.07	-0.22	5.68	2.15	-0.12	0.01	5.70	2.19	-0.09	0.27	5.80	2.24	-0.04	-0.30	5.55	2.14	0.03	-0.38	5.69	2.19	-0.04	-0.08
Item5	5.94	2.33	-0.02	-0.37	5.98	2.28	-0.29	-0.08	5.86	2.30	-0.17	0.03	6.28	2.38	-0.37	-0.19	5.82	2.18	-0.05	-0.49	5.96	2.30	-0.19	-0.20
Item6	5.97	2.38	-0.04	-0.40	6.08	2.24	-0.27	-0.06	5.95	2.34	-0.23	-0.01	6.14	2.28	-0.23	-0.28	6.07	2.23	-0.03	-0.54	6.04	2.29	-0.18	-0.21
Item9	5.72	2.13	0.01	0.08	5.76	2.01	-0.09	0.16	5.79	2.06	-0.04	0.47	5.85	2.10	-0.23	-0.01	5.58	1.99	0.10	-0.22	5.75	2.05	-0.05	0.13
Item11	5.83	2.22	-0.11	-0.20	5.94	2.16	-0.16	-0.04	5.83	2.18	-0.17	0.21	6.14	2.25	-0.23	-0.26	5.76	2.11	-0.03	-0.40	5.90	2.18	-0.14	-0.11
Item12	5.99	2.33	-0.09	-0.33	5.84	2.24	-0.13	-0.02	5.83	2.23	-0.10	0.24	5.91	2.30	-0.14	-0.26	5.98	2.31	-0.10	-0.55	5.89	2.27	-0.11	-0.14
Item15	6.03	2.46	-0.27	-0.28	6.17	2.44	-0.29	-0.53	6.00	2.41	-0.19	-0.27	6.17	2.59	-0.43	-0.55	6.25	2.36	-0.23	-0.57	6.12	2.45	-0.28	-0.44
Content																								
Item7	6.78	2.74	-0.64	-0.35	6.90	2.52	-0.66	-0.07	6.62	2.61	-0.54	-0.09	7.31	2.62	-0.99	0.30	6.77	2.52	-0.57	-0.49	6.85	2.60	-0.66	-0.17
Item8	5.82	2.47	-0.05	-0.45	5.88	2.27	-0.04	-0.15	5.80	2.27	-0.02	-0.03	6.13	2.47	-0.22	-0.27	5.69	2.31	0.06	-0.53	5.86	2.34	-0.05	-0.27
Item13	6.49	2.49	-0.26	-0.52	6.60	2.48	-0.35	-0.40	6.40	2.46	-0.27	-0.27	6.81	2.51	-0.51	-0.24	6.56	2.49	-0.22	-0.82	6.56	2.48	-0.32	-0.45
Item14	6.71	2.68	-0.53	-0.44	6.99	2.57	-0.64	-0.24	6.52	2.58	-0.41	-0.32	7.46	2.60	-1.07	0.53	6.91	2.61	-0.54	-0.61	6.89	2.62	-0.60	-0.33
Item16	6.73	2.45	-0.56	-0.01	6.85	2.43	-0.70	0.12	6.46	2.41	-0.58	0.28	7.29	2.44	-1.05	0.76	6.87	2.40	-0.43	-0.57	6.80	2.44	-0.65	0.06
Calm																								
Item2	5.55	2.15	0.17	-0.01	5.47	1.97	0.20	0.22	5.31	2.00	0.16	0.41	5.63	2.13	0.07	0.00	5.66	1.97	0.38	-0.18	5.50	2.03	0.19	0.14
Item10	5.84	2.15	0.02	-0.01	5.73	2.16	0.01	0.03	5.79	2.16	-0.06	0.21	5.86	2.28	0.03	-0.21	5.65	2.03	0.08	-0.09	5.77	2.16	0.01	0.01

Note: $SE_{sk(male)}$= 0.105, $SE_{ku(male)}$=0.209, $SE_{sk(female)}$= 0.081, $SE_{ku(female)}$=0.161, $SE_{sk(total)}$= 0.064, $SE_{ku(total)}$=0.128 ,

$SE_{sk(grade\ 7)}$= 0.096, $SE_{ku(grade\ 7)}$=0.192, $SE_{sk(grade\ 8)}$= 0.122, $SE_{ku(grade\ 8)}$=0.243, $SE_{sk(grade\ 9)}$= 0.120, $SE_{ku(grade\ 9)}$=0.238

Table 2 Goodness of fit test of alternative models

group	x^2	df	p-value	x^2/df	CFI	TLI	RMSEA	SRMR
Total	78.074	61	0.0694	1.280	0.998	0.995	0.014	0.016
Male	93.432	73	0.0538	1.280	0.992	0.987	0.023	0.028
Female	89.199	69	0.0514	1.293	0.996	0.993	0.018	0.021
Grade 7	101.949	83	0.0774	1.228	0.994	0.991	0.019	0.027
Grade 8	97.715	78	0.0649	1.253	0.991	0.987	0.025	0.030
Grade 9	97.809	78	0.0641	1.254	0.991	0.987	0.025	0.031

Table 3 Parameter estimates of standardized model results

Items	Male		Female		Grade 7		Grade 8		Grade 9		Total	
	β(SE)	R^2	β(SE)	R^2	β(SE)	R^2	β(SE)	R^2	β(SE)	R^2	β(SE)	R^2
Alarm												
Item1	0.442**(0.046)	0.195	0.439**(0.037)	0.193	0.535**(0.036)	0.286	0.434**(0.058)	0.189	0.469**(0.054)	0.220	0.470**(0.028)	0.221
Item3	0.480**(0.044)	0.230	0.571**(0.031)	0.326	0.582**(0.037)	0.338	0.622**(0.041)	0.387	0.636**(0.039)	0.405	0.604**(0.023)	0.365
Item4	0.541**(0.042)	0.293	0.629**(0.032)	0.395	0.676**(0.033)	0.457	0.587**(0.047)	0.344	0.587**(0.046)	0.345	0.633**(0.023)	0.401
Item5	0.623**(0.036)	0.388	0.650**(0.028)	0.423	0.734**(0.025)	0.538	0.573**(0.045)	0.329	0.571**(0.046)	0.327	0.676**(0.020)	0.457
Item6	0.637**(0.036)	0.405	0.676**(0.027)	0.457	0.801**(0.022)	0.641	0.650**(0.039)	0.422	0.665**(0.039)	0.442	0.791**(0.017)	0.626
Item9	0.634**(0.033)	0.402	0.691**(0.024)	0.478	0.697**(0.028)	0.486	0.679**(0.033)	0.462	0.682**(0.033)	0.465	0.705**(0.019)	0.497
Item11	0.740**(0.029)	0.548	0.762**(0.018)	0.581	0.741**(0.025)	0.549	0.780**(0.027)	0.609	0.779**(0.027)	0.607	0.761**(0.016)	0.578
Item12	0.663**(0.032)	0.440	0.628**(0.026)	0.394	0.676**(0.029)	0.458	0.620**(0.042)	0.385	0.616**(0.042)	0.380	0.641**(0.021)	0.410
Item15	0.692**(0.032)	0.478	0.669**(0.024)	0.447	0.657**(0.032)	0.431	0.662**(0.034)	0.438	0.662**(0.034)	0.438	0.607**(0.022)	0.369
Content												
Item7	0.708**(0.029)	0.501	0.753**(0.022)	0.567	0.763**(0.025)	0.582	0.687**(0.038)	0.472	0.671**(0.039)	0.451	0.700**(0.019)	0.490
Item8	0.605**(0.033)	0.366	0.652**(0.026)	0.425	0.665**(0.031)	0.442	0.688**(0.032)	0.473	0.689**(0.032)	0.475	0.662**(0.021)	0.438
Item13	0.772**(0.024)	0.596	0.763**(0.023)	0.583	0.695**(0.030)	0.483	0.780**(0.030)	0.608	0.777**(0.031)	0.603	0.703**(0.019)	0.494
Item14	0.688**(0.031)	0.478	0.658**(0.027)	0.433	0.674**(0.033)	0.455	0.588**(0.044)	0.345	0.561**(0.045)	0.315	0.572**(0.024)	0.327
Item16	0.681**(0.033)	0.464	0.653**(0.026)	0.426	0.681**(0.034)	0.464	0.610**(0.043)	0.372	0.588**(0.045)	0.346	0.579**(0.025)	0.335
Calm												
Item2	0.408**(0.052)	0.166	0.402**(0.035)	0.162	0.346**(0.046)	0.120	0.636**(0.047)	0.405	0.635**(0.047)	0.403	0.400**(0.030)	0.160
Item10	0.813**(0.050)	0.661	0.765**(0.038)	0.586	0.737**(0.060)	0.544	0.872**(0.027)	0.761	0.872**(0.027)	0.760	0.784**(0.033)	0.614

**p<0.01

Table 4 Factor correlation for 7 factors CFA of VAS

Model	Male			Female			Total		
factor	**1.**	**2.**	**3.**	**1.**	**2.**	**3.**	**1.**	**2.**	**3.**
1.Alert	1			1			1		
2.Content	1.001**	1		0.934**	1		0.947**	1	
3.Calm	0.921**	0.826**	1	0.988**	0.686**	1	0.951**	0.861**	1
Model	**Grade 7**			**Grade 8**			**Grade 9**		
factor	**1.**	**2.**	**3.**	**1.**	**2.**	**3.**	**1.**	**2.**	**3.**
1.Alert	1			1			1		
2.Content	0.973**	1		0.911**	1		0.918**	1	
3.Calm	1.005**	0.879**	1	0.857**	0.691**	1	0.849**	0.692**	1

**p<0.01

3. Measurement invariance across gender and grade

3.1 Measurement invariance across gender

To examined the measurement invariance hypothesis, a CFA approach was conducted with MPlus. The ML was used for testing measurement invariance. The fit indices for analyses across gender are presented in Table 5. The factorial invariance across gender was present in the measurement invariance and structural invariance. First, measurement invariance consists of testing configural invariance, Weak measurement invariance, strong measurement invariance, and strict measurement invariance.

Configural model, a two baseline model was examined for configural invariance, separately for in males and females. The model fit similarity for males and females: x^2(df = 69) = 104. 004, p<0. 001; CFI = 0. 991; TLI = 0. 984;SRMR = 0. 025, RMSEA= 0. 031; RMSEA 90%=[0.018,0.042] for males; and x^2(df =68)= 124.419,p<0.001;CFI = 0.992; TLI = 0.986; SRMR = 0.020; RMSEA = 0.030; RMSEA 90% = [0.022,0.038] for females. The male and female configural models fit the data well: x^2(df=137) = 228.423,p<0.001;CFI = 0.992; TLI =0.985; SRMR = 0.022; RMSEA = 0.030; RMSEA 90%=[0.023,0.037]. The results of testing metric invariance were Δx^2(df =13) = 13.788,p = 0.389 which was not statistically significant. In addition, there was no change in CFI. Therefore, the null hypothesis of metric invariance cannot be rejected. Metric invariance means that the relation between responses to the 16 VAS items and their underlying factors were not significantly different across gender. Since one factor loading of each factor, or "marker item", including item1, item7, and item2 were not tested in the LR test, the invariance of the marker items factor loading must be tested. The difference in model χ^2 statistics between models with and without equality restriction; Δx^2(df =10) = 12.652, p= 0. 244 which is not statistically significant, indicating that the factor loading of marker items was invariable across genders. Results from the LR test of scalar invariance show Δx^2(df = 29) = 35.910, p = 0.176 which is not statistically significant, but ΔCFI=0.001 is much smaller than 0. 01. Thus, the null hypothesis of the strong measurement invariance cannot be rejected. In other words, both the factor loading and item intercepts of the VAS are invariable across genders. Results from the LR test for strict measurement of two nested models of error invariance were: Δx^2(df = 45) = 121. 524, p = 5. 841 with no equality restriction on item invariance, which was statistically significant. The corresponding Δx^2(df =16) = 85.614, p =1.595 of equality restriction on item invariance which were not statistically significant. Thus, the results indicated that item variances were invariant across groups.

Results show that Δx^2(df =32) = 37.551,p = 0.230 which is not statistically significant. In addition, ΔCFI = 0.001 is much smaller than the cut-off point of 0.01. Therefore we concluded the factor variance was invariant across genders.

We found that Δx^2(df = 32) = 54.034, p = 0.009 which was significant. In addition, ΔCFI= 0.003 was much smaller than the cut-off point of 0.01. Therefore we concluded the factor covariance non-invariance across gender.

Finally, we tested mean variance which involves comparing the factor means across groups. For females all the factor means were fixed to zero for the reference group. Thus we found that Alarm (-0.032,P = 0.584), Content(-0.069,P = 0.236), and Calm(0.051,P = 0.420) were not significantly different between genders.

3.2 Measurement invariance across grades

3.2.1 Measurement invariance across Grade7 and Grade 8

The fit indices for measurement invariance analyses across Grade 7 and Grade 8 are presented in Table 6.

The configural model, Two baseline model was examined for configural invariance, separately for Grade 7 and Grade 8. The model fit similarity for Grade 7 and Grade 8: x^2(df=81)= 169.379,p<0.001; CFI = 0.983; TLI = 0.975; SRMR = 0.026, RMSEA = 0.041; RMSEA 90% = [0.032,0.050] for Grade 7; and x^2(df = 80) = 143.737, p<0.001; CFI = 0.978; TLI = 0.968; SRMR = 0.035; RMSEA = 0.048; RMSEA 90% = [0.033,0.045] for Grade 8. The Grade 7 and Grade 8 baseline models for analyzing the configural model fit the data well: x^2(df = 161) = 313.117, p<0.001; CFI = 0.981; TLI = 0.972; SRMR = 0.029; RMSEA = 0.043; RMSEA 90% = [0.035,0.049].

The results of testing the metric invariance were Δx^2(df = 13) = 48.575, p = 5.224 which was not significant. In addition, there was no change in CFI. Therefore, the null hypothesis of metric invariance cannot be rejected. Metric invariance means that the relation between responses to the VAS-16 items and their underlying factors are not different across Grade 7 and Grade 8. Since one of factor loading of each factor or "marker item", including item1, item7 and item2, were not tested in the LR test, there must be tested invariance of the marker items factor. The difference in model x^2 statistics between models with and without equality restriction; Δx^2(df =10) = 31.141, p = 0.001 which was significant, indicating that the factor loading of marker items were non-invariance across Grade 7 and Grade 8.

Results from the LR test of scalar invariance showed Δx^2(df = 29) = 144.564, p = 0.000 which was statistically significant and ΔCFI = 0.016 was much higher than 0.01. Thus, the null hypothesis of the strong measurement invariance can be rejected.

In other words, both factor loadings and item intercepts of the VAS were non-invariable across Grade 7 and Grade 8.

Results from a LR test of two nested models of error invariance were: Δx^2(df = 45)= 225.162, p = 0.000 with no equality restriction on item invariance which was statistically significant. The corresponding Δx^2(df = 16) = 80.598, p = 1.298 of equality restriction on item invariance which were not statistically significant. Thus, the results indicated that item variances were non-invariant across Grade 7 and Grade 8.

Results showed that Δx^2(df = 32) = 164.863, p=0.000 which is statistically significant. In addition, ΔCFI = 0.016 is higher than 0.01 which was not much smaller than the cut-off point of 0.01. The refore we concluded that the factor variance was non-invariance across Grade 7 and Grade 8.

Next, we found that Δx^2(df = 32) = 146.962, p = 1.110 which was not statistically significant. In addition, ΔCFI = 0.014 was higher than 0.01 which was not much smaller than the cut-off point of 0.01. Therefore we concluded that the factor covariance was non-invariance across Grade 7 and Grade 8.

Finally, the mean variance was tested by comparing the factor means across Grade 7 and Grade 8. The Grade 7 factor means were fixed to zero for the reference group. Thus we found that Content (0.323, P = 0.000) means were significantly higher in Grade 8 than in Grade 7. In other words Content measured by VAS was significantly higher in Grade 7 than in Grade 8.

Table 5 Measurement invariance summary fit statistics across genders

	Model	Comparison	x^2	x^2degree of freedom	CFI	TLI	SRMR	RMSEA	RMSEA 90% C.I.	Δx^2	Δdf	ΔCFI	x^2difference test (significance value)
Testing measurement invariance	*Configural invariance* Male baseline model (M1)	-	104.004	69	0.991	0.984	0.025	0.031	[0.018,0.042]	-	-	-	-
	Female baseline model (M2)	-	124.419	68	0.992	0.986	0.020	0.030	[0.022,0.038]	-	-	-	-
	Testing configural invariance (M3)	-	228.423	137	0.992	0.985	0.022	0.030	[0.023,0.037]	-	-	-	-
	Weak measurement invariance(M4)	-	242.211	150	0.991	0.986	0.027	0.029	[0.022,0.036]	-	-	-	-
	Factor loading invariance	M4-M3	-	-	-	-	-	-	-	13.788	13	-	0.389
	Maker items' factor loading invariance	M5-M6	-	-	-	-	-	-	-	12.652	10	-	0.244
	-without equality restriction on factor loading (M5)	-	242.211	150	0.991	0.986	0.027	0.029	[0.022,0.036]	-	-	-	-
	- with equality restriction on factor loading (M6)	-	229.559	140	0.992	0.986	0.023	0.030	[0.023,0.036	-	-	-	-
	Strong measurement invariance (invariance of factor loadings and item intercepts) (M7)	-	264.333	166	0.991	0.987	0.028	0.028	[0.022,0.035]	-	-	-	-
		M7-M3	-	-	-	-	-	-	-	35.910	29	0.001	0.176
	Strict measurement invariance (error variance invariance) (M8)	-	349.947	182	0.984	0.979	0.040	0.036	[0.030,0.041]	-	-	-	-
	- no equality restriction on item invariance	M8-M3	-	-	-	-	-	-	-	121.524	45	-	5.841
	- equality restriction on item invariance	M8-M7	-	-	-	-	-	-	-	85.614	16	-	1.595
Testing structural invariance	*Factor variance invariance* (M9)	-	265.974	169	0.991	0.987	0.031	0.028	[0.021,0.034]	-	-	-	-
		M9-M3	-	-	-	-	-	-	-	37.551	32	0.001	0.230
	Factor covariance invariance (M10)	-	282.457	169	0.989	0.985	0.035	0.030	[0.024,0.036]	-	-	-	-
		M10-M3	-	-	-	-	-	-	-	54.034	32	0.003	0.009
	Factor mean invariance	Alarm(-0.032,P=0.584), Content(-0.069 ,P=0.236), Calm(0.051 ,P=0.420)											

Table 6 Measurement invariance summary fit statistics across Grade 7 and Grade 8

	Model	Comparison	x^2	x^2degree of freedom	CFI	TLI	SRMR	RMSEA	RMSEA 90% C.I.	Δx^2	Δdf	ΔCFI	x^2difference test (significance value)
Testing measurement invariance	*Configural invariance*												
	Grade 7 baseline model (M_1)	-	169.379	81	0.983	0.975	0.026	0.041	[0.032,0.050]	-	-	-	-
	Grade 8 baseline model (M_2)	-	143.737	80	0.978	0.968	0.033	0.045	[0.033,0.056]	-	-	-	-
	Testing configural invariance (M_3)	-	313.117	161	0.981	0.972	0.029	0.043	[0.035,0.049]	-	-	-	-
	Weak measurement invariance(M_4)	-	361.692	174	0.977	0.968	0.045	0.045	[0.039,0.052]	-	-	-	-
	Factor loading invariance	M_4-M_3	-	-	-	-	-	-	-	48.575	13	-	5.224
	Maker items' factor loading invariance	M_5-M_6	-	-	-	-	-	-	-	31.141	10	-	0.001
	-without equality restriction on factor loading (M_5)	-	361.692	174	0.977	0.968	0.045	0.045	[0.039,0.052]	-	-	-	-
	- with equality restriction on factor loading (M_6)	-	330.551	164	0.980	0.970	0.036	0.044	[0.037,0.051]	-	-	-	-
	Strong measurement invariance (invariance of factor loadings and item intercepts) (M_7)	-	457.681	190	0.967	0.959	0.057	0.052	[0.046,0.058]	-	-	-	-
		M_7-M_3	-	-	-	-	-	-	-	144.564	29	0.014	0.000
	Strict measurement invariance (error variance invariance) (M_8)	-	538.279	206	0.959	0.953	0.058	0.056	[0.050,0.061]	-	-	-	-
	- no equality restriction on item invariance	M_8-M_3	-	-	-	-	-	-	-	225.162	45	-	0.000
	- equality restriction on item invariance	M_8-M_7	-	-	-	-	-	-	-	80.598	16	-	1.298
Testing structural invariance	*Factor variance invariance* (M_9)	-	477.980	193	0.965	0.957	0.061	0.053	[0.047,0.059]	-	-	-	-
		M_9-M_3	-	-	-	-	-	-	-	164.863	32	0.016	0.000
	Factor covariance invariance (M_{10})	-	460.079	193	0.967	0.959	0.062	0.051	[0.045,0.057]	-	-	-	-
		M_{10}-M_3	-	-	-	-	-	-	-	146.962	32	0.014	1.110
	Factor mean invariance	Alarm(0.081 ,P=0.240), Content(0.323,P=0.000), Calm(0.082 ,P=0.221)											

3.2.2 Measurement of invariance across Grade 8 and Grade 9

The fit indices for analyses across Grade 8 and Grade 9 are presented in **Table 7.**

The configural model, a two baseline model, was examined for configural invariance, separately for Grade 8 and Grade 9. The model fit similarity for Grade 8 and Grade 9: x^2(df= 80) = 143. 737,p<0. 001; CFI= 0. 978; TLI= 0. 968; SRMR= 0. 033, RMSEA= 0. 045; RMSEA 90% = [0. 033,. 056] for Grade 8; and x^2(df= 78) = 143. 526, p<0. 001; CFI=0.976; TLI=0.963; SRMR=0.036; RMSEA=0.045; RMSEA 90%=[0.033,0.056] for Grade 9. The Grade 8 and Grade 9 baseline models for analyzing the configural model fit the data well: x^2(df = 158) = 287.263, p<0.001; CFI=0.977; TLI=0.965; SRMR=0.035; RMSEA=0.045; RMSEA 90%=[0.036,0.053].

The results of testing metric invariance were x^2(df=13) = 42.695,p<0.000 which was significant. In addition, there was a change in CFI. Therefore, the null hypothesis of metric invariance can be rejected. Metric invariance means that the relation between responses to the VAS-16 items and their underlying factors were different across Grade 8 and Grade 9. Since one of the factor loadings of each factor, or " marker item" , including item1, item7, and item2, were not tested in the LR test so they must be tested for invariance of the marker items factor loading. The difference in model x^2 statistics between the models with and without equality restriction; Δx^2(df= 10) = 14.864, p= 0.137 which was not statistically significant, indicated that the factor loading of marker items were invariant across Grade 8 and Grade 9.

Results from the LR test of scalar invariance showed Δx^2(df= 29) = 103. 014,p= 3. 204 which was not statistically significant, but ΔCFI= 0. 013 was much higher than 0.01. Thus, the null hypothesis of the strong measurement invariance can be rejected. In other words, both factor loading and item intercept of the VAS are non-invariance across Grade 8 and Grade 9.

Results from the LR test of two nested models of error invariance were: Δx^2(df= 45) = 163.446, p= 2.331 with no equality restriction on item invariance which were not statistically significant. The corresponding Δx^2(df= 16) = 60. 432, p= 4. 425 of equality restriction on item invariance were not statistically significant. Thus, the results indicate that item variances are invariant across groups.

Results show that Δx^2(df=32) =132.641, p =3.275 which is not significant. In addition, ΔCFI=0.018 is much higher than 0.01 which is not much smaller than the cut-off point of 0.01. Therefore we concluded that the factor variance non-invariance across Grade 8 and Grade 9.

Next, we found that Δx^2(df= 32) = 114. 253, p= 3. 591 which is not significant. In addition, ΔCFI=0.014 was much higher than 0.01 which is not much smaller than the cut-off point of 0.01. Therefore we conclude that the factor covariance non-invariance across Grade 8 and Grade 9.

Finally, the mean variance was tested by comparing the factor means across groups. All the factor means for Grade 8 were fixed to zero as the reference group. Thus we found that Content(-0.220,P=0.006) was significantly lower in Grade 8 than in Grade 9, while the factor mean for Alarm (-0.086,P= 0.283) and Calm(-0.162,P=0.194) were not significantly different between the two grades. In other words Content measured by VAS was more significant in Grade 9 than in Grade 8; however, the Alarm and Calm were not significantly different between Grade 8 and Grade 9.

3.2.3 Measurement invariance across Grade7 and Grade 9

The ML was used for testing measurement invariance. The fit indices for analyses across Grade 7 and Grade 9 are presented in Table 8.

A Two baseline Configural model was examined for configural invariance, separately for Grade 7 and Grade 9. The model fit similarity for Grade 7 and Grade 8 was: x^2(df = 81) = 169.379, p<0.001; CFI = 0.983; TLI = 0.975; SRMR = 0.026, RMSEA = 0.041; RMSEA 90% = [0.032,0.050] for Grade 7; and x^2(df = 78) = 143.526, p<0.001; CFI = 0.976; TLI = 0.963; SRMR = 0.036; RMSEA = 0.045; RMSEA 90% = [0.033,0.056] for Grade 9. The Grade 7 and Grade 9 baseline models for analyzing configural model fit the data well: x^2(df =159) = 312.905, p<0.001; CFI = 0.981; TLI = 0.971; SRMR = 0.030; RMSEA = 0.043; RMSEA 90% = [0.036,0.050].

The results of testing the metric invariance were Δx^2(df = 13) = 27.170, p = 0.022 which is significant. In addition, there was a change in CFI. Therefore, the null hypothesis of metric invariance can be rejected. Metric invariance means that the relation between responses to the VAS-16 items and their underlying factors were different across Grade 7 and Grade 9. Since a factor loading of one for a factor or “marker item”, including

item1, item7 and item 2, were not tested in the LR test, the invariance of the marker items factor loading must be tested. The difference in model x^2 statistics between the models with and without equality restriction; $\Delta x^2(df=10)=22.212$, $p=0.014$ which was significant, indicating that the factor loading of marker items were non-invariance across Grade 7 and Grade 9.

Results from the LR test of scalar invariance showed that $\Delta x^2(df=29)=68.749$, $p = 0.000$ which was statistically significant but ΔCFI=0.005 was much smaller than 0.01. Thus, the null hypothesis of the strong measurement invariance can be rejected. In other words, both factor loading and item intercept of the VAS were non-invariance across Grade 7 and Grade 9.

Results from the LR test of two nested models of error invariance were: $\Delta x^2(df = 45) = 116.999$, $p = 2.531$ of no equality restriction on item invariance which were not statistically significant. The corresponding $\Delta x^2(df = 16) = 48.250$, $p=0.000$ of equality restriction on item invariance were statistically significant. Thus, the results indicated that item variances are non-invariant across Grade 7 and Grade 9.

The results showed that $\Delta x^2(df = 32)= 78.536$, $p = 8.699$ which was not statistically significant. In addition, ΔCFI = 0.006 was much smaller than the cut-off point of 0.01. Therefore we concluded that the factor variance invariance across Grade 7 and Grade 9.

Next, we found that $\Delta x^2(df = 32)= 78.522$, $p = 8.737$ which was not statistically significant. In addition, ΔCFI = 0.006 was much smaller than the cut-off point of 0.01. The refore we concluded that the factor covariance invariance across Grade 7 and Grade 9.

Finally, mean variance was tested by comparing the factor mean across Grade 7 and Grade 9. The Grade 7 factor means were fixed to zero for the reference group. We found that only Alarm (0.017,P = 0.815), Content (0.100, P = 0.157), and Calm (-0.031 , P = 0.758) were not significantly different between the two samples.

Table 7 Measurement invariance summary fit statistics across Grade 8 and Grade 9

	Model	Comparison	x^2	x^2 degree of freedom	CFI	TLI	SRMR	RMSEA	RMSEA 90% C.I.	Δx^2	Δdf	ΔCFI	x^2difference test (significance value)
Testing measurement invariance	*Configural invariance*												
	Grade 8 baseline model (M_1)	-	143.737	80	0.978	0.968	0.033	0.045	[0.033,0.056]	-	-	-	-
	Grade 9 baseline model (M_2)	-	143.526	78	0.976	0.963	0.036	0.045	[0.033,0.056]	-	-	-	-
	Testing configural invariance (M_3)	-	287.263	158	0.977	0.965	0.035	0.045	[0.036,0.053]	-	-	-	-
	Weak measurement invariance(M_4)	-	329.958	171	0.972	0.961	0.050	0.048	[0.040,0.055]	-	-	-	-
	Factor loading invariance	M_4-M_3	-	-	-	-	-	-	-	42.695	13	-	0.000
	Maker items' factor loading invariance	M_5-M_6	-	-	-	-	-	-	-	14.864	10	-	0.137
	-without equality restriction on factor loading (M_5)	-	329.958	171	0.972	0.961	0.050	0.048	[0.040,0.055]	-	-	-	-
	- with equality restriction on factor loading (M_6)	-	315.094	161	0.973	0.959	0.045	0.048	[0.040,0.056]	-	-	-	-
	Strong measurement invariance	-	390.277	187	0.964	0.954	0.057	0.052	[0.044,0.059]	-	-	-	-
	(invariance of factor loadings and item intercepts) (M_7)	M_7-M_3	-	-	-	-	-	-	-	103.014	29	0.013	3.204
	Strict measurement invariance (error variance invariance) (M_8)	-	450.709	203	0.956	0.948	0.066	0.055	[0.048,0.061]	-	-	-	-
	- no equality restriction on item invariance	M_8-M_3	-	-	-	-	-	-	-	163.446	45	-	2.331
	- equality restriction on item invariance	M_8-M_7	-	-	-	-	-	-	-	60.432	16	-	4.425
Testing structural invariance	*Factor variance invariance* (M_9)	-	419.904	190	0.959	0.949	0.069	0.054	[0.047,0.061]	-	-	-	-
		M_9-M_3	-	-	-	-	-	-	-	132.641	32	0.018	3.275
	Factor covariance invariance (M_{10})	-	401.516	190	0.963	0.953	0.065	0.052	[0.045,0.059]	-	-	-	-
		M_{10}-M_3	-	-	-	-	-	-	-	114.253	32	0.014	3.591
	Factor mean invariance												

Alarm(-0.086,P = 0.283), Content(-0.220,P = 0.006), Calm(-0.161,P = 0.194)

Table 8 Measurement invariance summary fit statistics across Grade 7 and Grade 9

	Model	Comparison	x^2	x^2 degree of freedom	CFI	TLI	SRMR	RMSEA	RMSEA 90% C.I.	Δx^2	Δdf	ΔCFI	x^2 difference test (significance value)
Testing measurement invariance	*Configural invariance*												
	Grade 7 baseline model (M_1)	-	169.379	81	0.983	0.975	0.026	0.041	[0.032,0.050]	-	-	-	-
	Grade 9 baseline model (M_2)	-	143.526	78	0.976	0.963	0.036	0.045	[0.033,0.056]	-	-	-	-
	Testing configural invariance (M_3)	-	312.905	159	0.981	0.971	0.030	0.043	[0.036,0.050]	-	-	-	-
	Weak measurement invariance(M_4)	-	340.075	172	0.979	0.970	0.040	0.043	[0.036,0.050]	-	-	-	-
	Factor loading invariance	M_4-M_3	-	-	-	-	-	-	-	27.170	13	-	0.012
	Maker items' factor loading invariance	M_5-M_6	-	-	-	-	-	-	-	22.212	10	-	0.014
	-without equality restriction on factor loading (M_5)	-	340.075	172	0.979	0.970	0.040	0.043	[0.036,0.050]	-	-	-	-
	- with equality restriction on factor loading (M_6)	-	317.863	162	0.980	0.971	0.031	0.043	[0.036,0.049]	-	-	-	-
	Strong measurement invariance	-	381.654	188	0.976	0.969	0.042	0.044	[0.038,0.050]	-	-	-	-
	(invariance of factor loadings and item intercepts) (M_7)	M_7-M_3	-	-	-	-	-	-	-	68.749	29	0.005	0.000
	Strict measurement invariance (error variance invariance) (M_8)	-	429.904	204	0.971	0.966	0.044	0.046	[0.040,0.052]	-	-	-	-
	- no equality restriction on item invariance	M_8-M_3	-	-	-	-	-	-	-	116.999	45	-	2.531
	- equality restriction on item invariance	M_8-M_7	-	-	-	-	-	-	-	48.250	16	-	0.000
Testing structural invariance	*Factor variance invariance* (M_9)	-	391.441	191	0.975	0.968	0.053	0.044	[0.038,0.051]	-	-	-	-
		M_9-M_3	-	-	-	-	-	-	-	78.536	32	0.006	8.699
	Factor covariance invariance (M_{10})	-	391.427	191	0.975	0.968	0.057	0.044	[0.038,0.051]	-	-	-	-
		M_{10}-M_3	-	-	-	-	-	-	-	78.522	32	0.006	8.737
	Factor mean invariance	Alarm(0.017,P=0.815), Content(0.100,P=0.157), Calm(-0.031 ,P=0.758)											

Conclusion and Discussion

The Bond-Ladder Visual Analogue Scale (VAS) has been used to assess mood over a long period of time (Freyd, 1923; Hayes and Patterson, 1921). Mood influences attention, memory, cognitive performance and information processing (Armitage et. al, 1999; Foa, McNally, and Murdock, 1989; Tildesley et.al, 2005; Van Honk et al, 1999). However, as we could not be confident in using VAS to measure student's mood, we conducted this study to establish confidence in this measure. Our research examined the validity of the VAS with students. The validity of the VAS was tested across both genders, and Grade7, Grade 8, and Grade 9. Total CFA models provided the best fit. It shows that VAS can measure the mood and can give the valid information for classroom management. The VAS was measured the mood in the learning classroom, was used the pre-post mood measurement. Morever, The mood research was used for producing the teaching model. (For examples please refer to- Bauer, Jordan, Soares, and Meyer (2015), Bunterm et. al (2014), Chen, Hu, and Plucker (2015), Srikoon, Bunterm, Nethanomsak, and Ngang, (2017)).

The results from this study provide evidence for the validity of the VAS. In the future the VAS can be used to measure students' mood for both genders and for Grades 7, 8 and 9. Moreover, this research investigated the measurement invariance across genders and grades because these are generally the most important variables in education (Evren et.al, 2015; Denton et al, 2015). We have now established mood variances for gender and grade.

The results provide a basis for guiding classroom management, a central aspect of education. As the MGCFA for gender was non-invariance, classroom management must consider the difference between genders, which corresponds to Evren, et al (2015). They found that learning outcome differ in each grades. This study concluded that gender is the most important variable in the study of social science. 24

Further, the MGCFA for grade was also non-invariance, so instructors must consider the difference between grades. This according with Cyders (2013) say that behaviors differ in each gender and teacher could use positive mood for designing learning activity. Moreover Srikoon, Bunterm, Nethanomsak, and Ngang, (2017) found that mood effect on learning outcome. Therefore, classroom learning must account for mood in instruction planning.

SUGGESTIONS

1. Suggestions for the application of research results

This results confirm that VAS was the effective tool for measuring the mood, so teacher should use the information from VAS for designing the classroom activity. VAS can measure the mood in pre-test for designing learning activity and post-test for evaluating

affective status. Teacher can use this mood's information for improving student's learning outcomes.

2. Suggestion for the future research

This research examine the construct validity of Thai student's VAS. In the future research we should examine the measurement invariance of VAS across the culture for adapting VAS in each context.

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